Advancing Diaphragm Modeling Technology for Propellant Management

Problem Statement

- High-acceleration spaceflight missions require use of diaphragms to control propellants.
- Future comet retrieval or rendezvous, on-orbit servicing, etc., missions can not rely on small accelerations.
- Modeling of the dynamics of mixed liquid and deformable solid motion remains computationally expensive, so simplifications are sought.
- One such simplification for design relies on a non-dimensional parameter for diaphragm and liquid interactions and this needs to be advance to TRL-6.

Technology Development Team

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Proposed Flight Experiment

Experiment Readiness:

- The experiment flew in June 2011 and remains nearly flight-ready. A new perturbation rig is to be installed.

Test Vehicles:

- Parabolic aircraft flight, either Zero-g Corp or S-3.

Test Environment:

- The 25 seconds of low-g suffices for one perturbation cycle per parabola. 30 parabolas and five tanks = 150 data points per day.

Test Apparatus Description:

- Five spherical test vessels permit great ranges in scaling, a new perturber is added, and video data acquisition are used.

Technology Maturation

- Flights in 2011 produced data inefficiently, leaving the primary question unanswered and TRL approaching 5.
- TRL 6 after the flight plus knowledge of performance differences from traditional technology.
- Testing to reach TRL 7 or expanding to other tank geometries could be the next steps if this test program is successful.

Objective of Proposed Experiment

- Create the necessary test cases for determining boundaries between three regimes of diaphragm-liquid interactions.
- Advance the technology useful for design tasks to TRL-6,
- Gather video data on diaphragm response to enable next advances in modeling for system design.

Technology Area TA02 In-Space Propulsion Systems

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